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ABSTRACT

A recently issued report entitled "A Study of Our Nation's Schools" (Mayeske, 1959, SP 003 563) utilized the Educational Opportunities Survey data collected by direction of Congress in 1965. A large number of variables were reduced into a fewer number of indices for use in regression analysis. A technique for the partition of multiple correlation showed that for achievement, very little of the influence of the schools can be separated from the social background of their students, and vice versa. Those aspects of the schools most involved in student achievement pertained to the teaching staff's verbal skills, racial-ethnic composition, salary level, special staff and services, and their view of their teaching conditions. The existence of a dominant color-caste system in the preparation of teachers was discovered. Although schools play an important role in promoting achievement for all students, students from the higher socioeconomic status, mostly white, were found to benefit more from their schooling than those from the lower socioeconomic strata, many non-white. Innovations must be tried that would break these social background barriers. (Steps employed in reducing variables into indices and the utilization of indices in regression analysis are described. Appendixes contain lists of the student, teacher, principal, and school indices, give definition of sets of variables, and describe the development of measures of commonality for three sets of variables.) (JS)

ED037398

Teacher Attributes and School Achievement

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Introduction

My colleagues* and I in the U.S. Office of Education have been privileged to be charged with the responsibility of illustrating and documenting the structure and functioning of the American public school system. We could not dream of having such a lofty objective if we did not have at our disposal the most comprehensive body of data ever collected on public schools and their students in the United States. I am, of course, referring to the Educational Opportunities Survey data collected in the fall of 1965 at the direction of Congress in the Civil Rights Act of the prior year. A report utilizing this data to investigate the Equality of Educational Opportunity for various racial and ethnic groups was issued in the fall of 1966 under the principal authorship of James S. Coleman. Today I would like to present excerpts from a recently issued report entitled "A Study of Our Nation's Schools" that utilized this same body of data (Mayeske, et.al., 1969). But let me first focus on the nature and scope of the data base, the background work that was done in preparation for the "School" study and an important related development.

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The Data Base and Background Work for the School Study

The Educational Opportunities Survey entailed the testing and surveying of about 650,000 students in some 4000 public schools throughout the country in grades 1, 3, 6, 9 and 12, together with their teachers, principals and superintendents. The Survey sample consisted of a 5 percent sample of schools. The data base is comprehensive in that detailed factual and attitudinal information was collected on the students home background, attitude towards school, race relations and the world. A battery of ability and achievement tests was administered at each grade level. Information was collected from some 60,000 teachers and 4,000 principals concerning their training and experience, their view of the school, etc. The final part of the teacher questionnaire consisted of a 30 item contextual vocabulary test which was intended to be a measure of the verbal facility of the teacher. In addition, the principal provided data on the school's facilities, staff, programs, curricula, etc. For further detailed information on the survey data I will refer you to the report "Equality of Educational Opportunity" (Coleman, et.al., 1966).

The main goal of our background work was to reduce the more than 400 variables in an empirically meaningful way into indices and sets of indices so that the volume of data processing and complexity of later analyses could be reduced. Before the variables could be reduced into meaningful groupings, however, decisions had to be made concerning the estimation of missing data and the coding or scaling of variables. As a guide in the estimation of missing data or handling of non-responses, it was decided to analyze the responses to each question against one or more criteria or dependent variables so that not only the percent responding to each

item or response alternative, but also their mean score on the dependent variable could be used as a guide in coding the variables and in assigning a value to the non-respondents. Since the approach differed somewhat for the student, teacher and principal questionnaires each analysis will be described separately.

A factor analysis of the five ninth grade achievement measures* showed that a single factor could be used to described their intercorrelations**. Accordingly, the weights from the first principal component of the intercorrelations were used to weight scores on the individual tests and sum them to obtain an overall achievement composite. It was this composite which was used as a criterion against which item responses were analyzed. This composite is also the dependent variable for many later analyses.

In order to maximize the linear relationship of each student variable with student achievement, criterion scaling (Beaton, 1969) was employed. By criterion scaling is meant that each item response was coded or scaled by assigning the mean value of the dependent variable for each of the different response alternatives for an item***.

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* The tests were: General Information; Reading Comprehension; Mathematics Achievement; Verbal Ability and; Non-Verbal Ability.

** The first principal component of the intercorrelations accounted for 75 percent of the variance.

*** Almost all of the ninth grade student variables were coded in this manner. When the results of this scaling technique were compared with a more conventional procedure it was found that they were very similar except for some of the attitudinal items which were linearized by the criterion scaling procedure.

For the teacher variables, each item was analyzed against the teacher's total score on a self-administered contextual vocabulary test. For the principal variables, each item was analyzed against the number of students enrolled in the school, the rural-urban and socio-economic status of the school and, the principal's salary. These analyses were used as guides in assigning codes or scale values and in estimating missing data*.

To obtain meaningful groupings of variables, the intercorrelations of the student, teacher and principal sets of variables were each subjected to a series of factor analyses. The Principal Component technique was used to extract components and the Varimax technique was used to rotate components having a root of one or greater (Horst, 1965). This approach was essentially iterative in that variables that did not form meaningful groupings or blurred an otherwise meaningful grouping were eliminated and the remaining variables were refactored. The teacher and student variables readily fell into meaningful groupings after two iterations which resulted in the elimination of about six to twelve variables from each set. The highest weights from the Varimax rotation were used to combine the variables to obtain index scores. In order to keep the index score intercorrelations low a variable was allowed to have a weight on only one index.

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* However, for the teachers and principals questionnaires the items were not coded so as to maximize their relationship with these dependent or criterion variables.

The variables from the principal questionnaire dealt with a wide variety of different aspects of the school. These variables did not readily fall into any naturally meaningful groups. Consequently, a priori groupings, such as variables concerned with the physical plant or instructional facilities were subjected to a Principal Component analysis. The weights from the first principal component were then used to obtain index scores for each school.

A brief description of the indices obtained and other variables retained for future analyses are given in the Appendix. Time does not permit for a full discussion of them, however, they are given for reference purposes. When I refer to the full set of school variables later on I will be referring to the combined set of 31 teacher, principal and school indices that are given in the Appendix. Using these indices we have conducted extensive among school analyses, a small portion of which I would like to present today. These analyses used ninth grade schools as the unit of analysis. Thus, when we speak of Socio-Economic Status we are talking about the average of the Socio-Economic index scores for the ninth grade students in a particular school and when we speak of Achievement we are talking about the average achievement of ninth grade students in a school. In a similar manner we are talking about the average Experience or Training of the teachers in a school. There were 923 schools and 133,136 students used in these analyses.

Before we get into the results of these analyses, however, let me touch on an important related development.

The Commonality Model

At about the time we were beginning the School study Alex Mood came forth with a technique for the partition of multiple correlation which was to have profound implications for our work. This technique, which we were to discover had been developed independently at an earlier date by Newton and Spurrell (1967) may be described as follows:

> Suppose we have a set of student body variables, B, and a set of school variables, S, and we want to ascertain the contribution that the S variables make to Achievement after adjusting Achievement for differences in the B variables. Upon performing this operation we find that the contribution of the S variables is small. Performing the operation in the reverse order we find that the contribution of the B variables is small. We say that the contribution is small in that the squared multiple correlation for each set of variables is large. We conclude that there must be a high degree of overlap in the way these sets of variables relate to Achievement and would like to express this quantitatively.

Let: C(B,S) stand for commonality or overlap of the student body variables (B) and school variables (S) as they relate to Achievement

$R^2(B)$ - the squared multiple correlation of the student body variables with Achievement

$R^2(S)$ - the squared multiple correlation of the school variables with Achievement

$R^2(B,S)$ - the squared multiple correlation of the student body and school variables with Achievement

$U(B) = R^2(B,S) - R^2(S)$, that portion of the squared multiple correlation uniquely attributed to the student body variables

$U(S) = R^2(B,S) - R^2(B)$, that portion uniquely attributed to the school variables

Then $C(B,S) = R^2(B,S) - U(B) - U(S)$* and $R^2(S)$ and $R^2(B)$ can be expressed as:

$$R^2(S) = C(B,S) + U(S)$$

$$R^2(B) = C(B,S) + U(B)$$

In the following pages these results are "unitized" by dividing the unique and common portions by the squared multiple correlation obtained for both sets of variables combined (viz. $R^2(B,S)$). This "unitizing" operation converts the unique and common portions so that they sum to 100 percent.

In its strictest sense this common portion represents an indeterminate situation. That is to say, we cannot tell to which of the two sets, B or S, all or some part of this common portion should be attributed. Later I shall try to attribute some special meaning to this common portion.

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* A generalization to three and four sets of variables is given in the Appendix

The School Study

The objective of this study (Mayeske, et.al., 1969) was to determine those aspects of schools which might be most effective in promoting student achievement and motivation. However, in this presentation I have chosen to focus on the results for Achievement.

We found that about 36 percent of the differences among students in their Achievement is associated with the schools they attend*. This leaves 64 percent to be explained by within school and non-school factors. In the analyses that follow the 36 percent will be the base or the maximum amount that can be explained. That is, if we were to obtain a multiple correlation of one between student body and school factors and Achievement then we would have explained the entire 36 percent.

In attempting to ascertain the influence of school variables on Achievement we wanted to take into account the kinds of students that the schools get initially. For example, if school "X" had children from families where intellectual activities were not valued or pursued and school "Z" had children from families where these activities were valued or pursued then one would expect the students in school "Z" to have higher Achievement levels than students in school "X". These differences could be attributed to the influence of the different families rather than to the schools. Thus, it seemed appropriate to equate schools for differences in the family Social Background of their students before looking at the

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* See the Appendix for the specific computational formula used to obtain this value.

possible influence of school variables on Achievement. To represent the Social Background of their students the indices of Socio-Economic Status, Family Structure and Stability and Racial-Ethnic Group Membership were used. Hereafter, these will be referred to as the set of Student Body Social Background (B) variables. To represent possible school influences the comprehensive set of thirty-one school variables (given in the Appendix) was used. This set will hereafter be referred to as the School set (S).

As described in the development of the Commonality Model, when the B and S sets were entered into the regression, large squared multiple correlations were observed for each set alone as well as in combination. The portion of variance that could be uniquely associated with one or the other set, however, was small relative to the magnitude of these correlations. This suggested that there was a high degree of overlap or confounding in the way these two sets of variables related to the dependent variable. To express this overlap we performed a commonality analysis for which the "unitized" results are given in Table 1.* In this table the U(Xi) denotes that portion of the "explained" variance (viz. $R^2(B,S)$) that has been uniquely attributed to the B or S set while C(B,S) indicates the portion that is in common. The unique portion for one set, say B, and the common portion sum to the percent of explained variance accounted for by that set (e.g. 12 plus 82 or 94 is the portion of explained variance accounted for by B). Similarly, the two unique portions and the common

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* Results identical to these were obtained when a more conventional coding technique was used for the student questionnaire items.

Table 1. - Unitized Commonality Analyses of B and S Variables With Achievement

	B	S
U(Xi)	12	6
C(BS)	82	82
	R^2 (BS) = 87	

portion sum to 100. All values have been rounded to two places of decimals and leading decimal points omitted.

The really outstanding aspect of the results in this table is the large percentage of overlap or confounding that exists among the B and S variables. We can't really tell to which one of the sets this value of 82, or some part of it, should be attributed. The other values are much smaller in magnitude with the unique portion for the S set being 6 percent and for the B set, 12 percent. About all we can conclude for now is that most of the influence of the schools is bound up with the Social Backgrounds of their students and vice-verse.

To further illustrate this latter point we can observe the role that Other School Outcomes (O) play in conjunction with the B and S sets. By Other School Outcomes we will mean the four attitudinal and motivational indices of: Expectations for Excellence; Attitude Towards Life; Educational Plans and Desires and; Study Habits (see Appendix). Results of commonality analyses using these three sets of variables are given in Table 2. For three sets of variables there will be a unique value for each set, a value for each of the pairwise combinations (viz. B and S, B and O and, S and O) and a value for the three way combination (BSO).

Table 2. - Unitized Commonality Analyses of B, S and O Variables With Achievement

	B	S	O
U(Xi)	7	3	2
C(BS)	30	30	
C(BO)	5		5
C(SO)		2	2
C(BSO)	51	51	51
	R^2(BSO) = 88		

Inspection of Table 2 shows again that most of the variance in Achievement explainable from the B, S and O sets is confounded. The portions uniquely attributable to B, S and O are 7, 3 and 2 percent respectively. That leaves 88 percent (100 minus 7 plus 3 plus 2) as being involved in the higher order combinations. For the two way combinations a large amount (30 percent) is involved in B and S, with 5 and 2 percent for the BO and SO combinations. Just over half of this explained variance is in the three way combination of B, S and O. From these observations we can conclude that most of the influence of the schools on Achievement is bound up with the Social Background and motivational levels of the students they get initially (and vice-verse).

We might ask then if there is some subset of S for which this overlap or confounding is greatest. Perhaps this would give us a rough idea of those aspects of the schools that are wielding the greatest influence. Table 3 gives the results of commonality analyses for four sets of variables where the S set has been broken down into the three subsets

of School Personnel (T), Pupil Programs and Policies (P) and Plant and Physical Facilities (F). The indices comprising each set are given in the Appendix. As with the earlier analyses, there is a value for each higher order combination.

Inspection of Table 3 shows that the areas of overlap are greatest when the B and T sets are involved and negligible elsewhere. The largest value (56 percent) is for the two way combination of B and T. The other two way combinations are small to negligible. The three way combinations of BTP and BTF also contain moderate values as does the four way combination BTPF. Table 3 shows clearly that the sets for which the confounding is greatest are those where B, the Student Body Social Background and T, the School Personnel are present. The Pupil Programs and Policies (P) and Facilities (F) sets show moderate values only in conjunction with the B and T sets.

We might ask them if there are any particular aspects of the School Personnel (T) set for which this confounding is greater. Table 4 gives commonality analyses of the B and S sets with Achievement when the Racial-Ethnic Composition of the teaching staff is deleted from the S set.

Table 3. - Unitized Commonality Analyses of B, T, P and F Variables With Achievement

	B	T	P	F
U(Xi)	12	2	1	0
C(BT)	56	56		
C(BP)	2		2	
C(BF)	0			0
C(TP)		1	1	
C(TF)		0		0
C(PF)			1	1
C(BTP)	14	14	14	
C(BTF)	4	4		4
C(BPF)	1		1	1
C(BTPF)	6	6	6	6

R^2(BTPF) = 87

When the results in Table 4 are compared with those in Table 1 we note that the coefficient of overlap drops by 14 percent, the unique portion for B increases by 15 percent and the unique portion for S decreases by 1 percent. What was at first attributed to overlap or confounding has now become attributed to the Student Body Social Background (B). Other analyses showed that as we eliminated "social condition" type variables from the S set such as Free Lunch and Milk Programs, and the index called Teaching Conditions (which pertains to the teacher's view of how much effort the students put forth to achieve, how readily they can maintain order, the extent of student disciplinary problems, etc.), the coefficient of overlap tended to decrease as well as the unique portion for S while that for B tended to increase.

Table 4. - Unitized Commonality Analyses of B and S With Achievement When the Racial-Ethnic Composition of the Teaching Staff is Deleted From S

	B	S
U(Xi)	27	5
C(BS)	68	68

$R^2(BS) = 86$

Still other analyses showed that after schools were equated for their student's Social Background, variables such as: verbal skills of the teaching staff; their annual salary level; their racial-ethnic composition; their Teaching Conditions and; the special staff and services that the schools offered continued to have relationships with Achievement. Although these relationships were not large they were suggestive. However, when some of the possible determinants of individual teacher's verbal skills were examined it was found that their racial-ethnic group membership accounted for a very large portion of these verbal skill differences. Indeed, the existence of a dominant color-caste system in the preparation of teachers was discovered and the self-perpetuating role that it could play through the reinforcement of differential verbal skills along racial and ethnic lines was suggested whereby teachers tend to teach students from the same socio-economic and racial-ethnic background as their own.

An Interpretation of the Measure of Confounding

We have seen that a large degree of overlap or confounding exists between the school's resources and the student's Social Background as they relate to Achievement. It is suggested that part of this confounding

reflects the nature of the educational process whereby students from the higher socio-economic strata who have an intact family structure and happen to be white or Oriental enter school with more fully developed skills and motivation which enable them to benefit more from their schooling than their less privileged counterparts. Support for this line of reasoning comes from some of our own analyses utilizing the time dependent aspects of the EOS data as well as work by Shaycoft (1967).

Using the time dependent aspects of the EOS data* it was found that after schools were equated for differences in the Achievement levels of their first grade students, the measure of confounding or overlap between B and S was larger than their unique portions at the third grade. By the sixth grade, although the unique portions of B and S increased very little their common portion almost doubled its value from what it was at the third grade. Another way of saying this is that the longer the students are in school, even though they start out at the same level of Achievement, the larger becomes the coefficient of overlap or confounding between the B and S sets. A study by Shaycoft (1967) using data taken from the same students measured at two points in time tends also to support the results obtained in these analyses. Shaycoft found that after equating or equalizing students for their initial achievement, students from the higher socio-economic strata showed greater gains on a later testing than did students from the lower socio-economic strata.

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* These were schools for which data was available on their first, third and sixth grade students. The first grade students were considered as a surrogate for what the third and sixth grade students were like when they entered first grade, the third grade students were considered as a surrogate for what the sixth grade students were like when they were in the third grade, etc.

What we are suggesting then is that this measure of overlap represents, in part, the interaction of the student's Social Background mainly with the school's staff and, to a lesser extent also with the school programs. We cannot be more precise about what part of this overlap is due to this kind of interaction for there are also other factors at work. For example, we find even at the first grade that relationships exist between the Achievement levels of the entering students and the attributes of the schools they attend. Thus, schools with entering students of higher Achievement levels have associated with them teachers with higher verbal skills who tend to be white and express a preference for working with high ability students, etc. We find also that these relationships with Achievement tend to increase at the higher grade levels as well as the relationship of Achievement with the students Social Background. This phenomenon suggests what I would like to call the "ecological-functional dilemma" in studying school influences. At the beginning of the first grade, students are allocated into schools on the basis of their Social Background and certain relationships are observed between the attributes of the students and their schools. This we call an ecological relationship. Over time, since students with a higher Social Background benefit more from their schooling, ecology and the school's influences (or what we have chosen to call functionality) become more and more intertwined so that it becomes increasingly more difficult to separate out their independent influences.

Do Schools Have Important Influences on Their Students?

What these analyses have shown I believe, is that the schools reflect a deep seated social problem which permeates almost every aspect of our

society. This problem, in the main, is that one's birth into a particular stratum of our social structure plays a large role in determining where he will go and will not go in the scheme of things. The problem is made even more difficult, however, because one's skin color and language habits tend to be associated with one's position in this social structure.* If this interpretation has any validity then it does not seem likely that the schools alone can rectify the problem although they may play an ameliorative role. It seems more likely that the problem warrants a concerted attack from many different sectors of society (viz. jobs, housing, schooling, etc.).

Given that a concerted effort is warranted we might ask what role the schools can play in this effort. We have seen that as the schools are currently constituted very little of their influence can be separated from the Social Background of their students and very little of the Social Background of students can be separated from the influence of their schools. This should not be construed to mean that schools do nothing for their students. Schools do a great deal for all students and this was dramatized in a recent study of children in Prince Edward County (Green, 1964) who had their schooling interrupted for a few years. When the test performance of these children was compared with children of a comparable background in a neighboring county it was found that they were 16 to 30 points lower on an IQ test, which was used as a measure of learning. In addition, the young children who would have ordinarily completed the first few grades but were

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* Although as two large scale studies have shown (Husén, Plowden), where skin color is not an issue class membership is still very much an issue in the benefits students accrue from their schooling.

unable to even start school, could not even hold a pencil nor follow directions, let alone take a test. Thus schools, even in conditions of poverty, do have important influences on their students. The problem is how to increase the influence of the schools to overcome the effects of these social background barriers.

When we focus on those aspects of the schools that have been altered and resulted in some degree of success (e.g. language enrichment, remedial reading) we find that these were usually on a limited scale and are difficult to repeat even in similar settings (Hawkridge, et.al., 1968). These experiences coupled with the observation that the influence of the schools that is independent of student Social Background is very small, suggest that we should be trying new approaches that differ radically from past practices in situations so structured that the results of the innovations can be clearly ascertained. A range of innovations have been proposed including schools with more socio-economically and racially balanced student bodies and teaching staffs, intensified further training of teachers of the disadvantaged perhaps coupled with pay supplements, schools that focus mainly on reading and mathematics, boarding schools and, competitive schools or some form of voucher system whereby the student and his family can select services from a variety of sources, etc. These are all ideas worthy of trial. Some may fail, but the greatest failure of all is not to try, for no one currently knows the magnitude of the role that the schools can play in helping to ameliorate this deep seated social problem.

Summary

This article presents excerpts from a report entitled "A Study of Our Nation's Schools". Steps employed in the reduction of a large number of variables into a fewer number of indices and the utilization of these indices in regression analyses are described. A technique for the partition of multiple correlation showed that for Achievement, very little of the influence of the schools can be separated from the Social Background of their students and very little of the influence of student Social Background can be separated from their schools. Although the relationships were not large, those aspects of the schools most involved in student Achievement pertained to the teaching staff's verbal skills, racial-ethnic composition, salary level, special staff and services and their view of their teaching conditions (e.g. how much effort the students put forth, how readily they can maintain order, the extent of the student disciplinary problems, etc.). When the backgrounds of individual teachers were examined the existence of a dominant color-caste system in the preparation of teachers was discovered. The self-perpetuating role that it could play through the reinforcement of differential verbal skills along racial-ethnic lines was suggested whereby teachers tend to teach students from the same socio-economic and racial-ethnic background as their own.

The schools play an important role in promoting achievement for all students but as the schools are currently constituted students from the higher socio-economic strata (of whom most are white) benefit more from their schooling than students from the lower socio-economic strata (many of whom are non-white).

It is suggested that to break these social background barriers innovations that differ radically from past practices be tried in situations so structured that the results of the innovations can be clearly demonstrated. Suggested innovations range from more socio-economically and racially balanced student bodies and teaching staffs to competitive school systems or voucher systems whereby the student and his family can select services from a variety of sources.

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APPENDIX

Student Indices

1. Expectations for Excellence - student believes that his mother, father and teacher want him to be a good student and he desires to be a good student,

2. Socio-Economic Status - defined by mother's and father's educational level, father's occupational level, rooms in the home, number of siblings, reading materials and appliances in the home and urbanness of background,

3. Attitude Towards Life - a student with a high score on this index believes that people like himself have a chance to be successful, when he tries to get ahead he won't experience many obstacles, hard work is more important than good luck for success, won't have a hard time getting a job with a good education, etc.,

4. Family Structure and Stability - a student with a high score has both his father and mother in the home, father is the major source of income, he hasn't changed schools recently, etc.,

5. Educational Desires and Plans - a student with a high score desires and plans to go to college, his parents want him to go to college and he has high occupational level aspirations,

6. Study Habits - a student with a high score spends about 2 hours a day studying, has frequent discussions about his school work with his parents, was read to as a child before he started school, read many books during the summer, etc.

7. Racial-Ethnic Differences in Achievement - a variable created by assigning each student the average achievement score obtained by his racial or ethnic group.

Teacher Indices

1. Experience - comprised of the teacher's age, years of teaching experience and years of teaching in his present school,

2. Teaching Conditions - comprised of various aspects of the teacher's view of his teaching situation such as how hard the students try to achieve, their academic ability, the reputation of the school and student disciplinary, racial, etc. problems,

3. Localism of Background - a teacher with a high score has spent most of his life in a small geographic area and has graduated from high school and college in that locale,

4. Socio-Economic Background - comprised of the teacher's parent's educational level, father's occupation and rural-urbanness of their background,

5. Training - comprised of the teacher's highest degree held, certification, salary level and tenure,

6. College Attended - comprised of the kind of undergraduate institution attended (e.g. normal school, public or private university, etc.) the highest degree offered by that institution and teacher's rating of the academic level of the institution,

7. Teaching Related Activities - comprised of the hours of unofficial time spent in preparation for class and counseling, the number of educational journals read regularly, etc.,

8. Preference for High Ability Students - teacher prefers to work with students of higher ability, socio-economic status, etc.,

9. Sex - scored high for a female, low for a male,

10. Racial-Ethnic Differences in Contextual Vocabulary - a variable created by assigning each teacher the average vocabulary score obtained by his racial or ethnic group,

11. Vocabulary Score - total number of items correct.

Principal and School Indices

1. Principal's Experience - comprised of age, number of years experience as a principal, etc.,

2. Principal's Training - comprised of the highest degree held and salary level,

3. Principal's College Attended - same as teachers index,

4. Principal's Sex - a variable scored high for female, low for a male,

5. Plant and Physical Facilities - area of plant, possession of auditorium, gymnasium, etc.,

6. Instructional Facilities - special labs, shops, volumes in the library, etc.,

7. Specialized Staff and Services - art, music and remedial reading teachers, etc.,

8. Tracking - use of various kinds of ability grouping techniques,

9. Testing - frequency of different kinds of testing,

10. Transfers - number of students transferring in and out,

11. Remedial Programs - percent of students in remedial math and reading,

12. Free Milk and Lunch Programs - percent of students who get free milk and lunch,

13. Accreditation - whether or not school has state and regional accreditation,

14. Age of Texts - age of different texts used,

15. Availability of texts,

16. Age of Building - a variable,

17. Pupils per room - a variable,

18. Pupils per teacher - a variable,

19. Number of students enrolled in the school,

20. School Reputation - the principal's estimate of the school's reputation.

Definition of Sets of Variables

School (S) - eleven Teacher indices plus twenty Principal and School indices - 31 variables

Plant and Facilities (F) - Principal and School indices 5, 6, 16 and 17 - 4 variables

School Personnel (T) - the eleven Teacher indices plus Principal and School indices 1, 2, 3, 4, 7 and 20 - 17 variables

Pupil Programs and Policies (P) - the ten Principal and School indices not included in F and T above - 10 variables

Student Body Social Background (B) - Student indices 2, 4 and 7 - 3 variables

Other School Outcomes (O) - Student indices not included in B above - 4 variables

Development of Measures of Commonality for Three Sets of Variables

Consider the case where there are three sets of variables: a set of Student Body Background variables (B); a set of School variables (S) and; a set of other Outcome measures (O). Then the first order commonality coefficient or portion of the squared multiple correlation that is uniquely associated with a given dependent variable is:

$$U(B) = R^2(B,S,O) - R^2(S,O)$$

$$U(S) = R^2(B,S,O) - R^2(B,O)$$

$$U(O) = R^2(B,S,O) - R^2(B,S)$$

where $R^2(\ )$ represents the squared multiple correlation for the particular set of variables in parentheses with the dependent variable.

The second order commonality coefficients are given by:

$$C(BS) = R^2(B,S,O) - R^2(O) - U(B) - U(S)$$

$$C(BO) = R^2(B,S,O) - R^2(S) - U(B) - U(O)$$

$$C(SO) = R^2(B,S,O) - R^2(B) - U(S) - U(O)$$

and the third order commonality coefficient of which there is only one, is given by:

$$C(BSO) = R^2(B,S,O) - R^2(B,S) - R^2(B,O) - R^2(S,O) - U(B) - U(S) - U(O)$$

The squared multiple correlation for any single set can then be expressed as a function of it's different order commonality coefficients. For example, the squared multiple correlation for the Outcome set ($R^2(O)$) can be expressed as:

$$R^2(O) = C(BSO) + C(BO) + C(SO) + U(O)$$

Development of Measures of Commonality for Four Sets of Variables

Let the four sets of variables be denoted by X_1, X_2, X_3, and X_4. Then the unique portion or first order commonality coefficients for the ith set is given by

$$U(X_i) = R^2(X_1X_2X_3X_4) - R^2(X_jX_kX_l)$$

where $R^2(\ )$ represents the squared multiple correlation for the particular set of variables in parentheses with the dependent variable. As an example, the unique portion for the fourth set would be written as

$$U(X_4) = R^2(X_1X_2X_3X_4) - R^2(X_1X_2X_3)$$

There is one unique value for each set of variables, namely four in this case

The second order commonality coefficient is given by

$$C(X_iX_j) = R^2(X_1X_2X_3X_4) - R^2(X_kX_l) - U(X_i) - U(X_j)$$

As a example, the second order commonality coefficient for the third and fourth sets is

$$C(X_3X_4) = R^2(X_1X_2X_3X_4) - R^2(X_1X_2) - U(X_3) - U(X_4)$$

There is one second order commonality coefficient for each combination of sets, namely six in this case.

The third order commonality coefficient is given by:

$$C(X_iX_jX_k) = R^2(X_1X_2X_3X_4) - R^2(X_l) - C(X_iX_j) - C(X_iX_k) - C(X_jX_k) -$$
$$- U(X_i) - U(X_j) - U(X_k)$$

There is one-third order commonality coefficients for each three way combination, namely four in this case.

The fourth order commonality coefficient, which there is only one, is given by:

$$C(X_1X_2X_3X_4) = R^2(X_1X_2X_3X_4) - R^2(X_1X_2X_3) - R^2(X_1X_2X_4) - R^2(X_1X_3X_4)$$
$$- R^2(X_2X_3X_4) - R^2(X_1X_2) - R^2(X_1X_3) - R^2(X_1X_4) - R^2(X_2X_3) - R^2(X_2X_4)$$
$$- R^2(X_3X_4) - U(X_1) - U(X_2) - U(X_3) - U(X_4)$$

The fourth order coefficient can be verbally described as the squared multiple correlation for all four sets $R^2(X_1X_2X_3X_4)$ minus the sum of the four third order commonalities $C(X_jX_kX_1)$, minus the sum of the six second order commonalities $C(X_jX_k)$, minus the sum of the four unique portions.

Consequently, the squared multiple correlation for the X_4 set can be represented as the sum of its unique value and its different order commonalities, thus:

$$R^2(X_4) = C(X_1X_2X_3X_4) + C(X_1X_2X_4) + C(X_1X_3X_4) + C(X_2X_3X_4) + C(X_1X_4)$$
$$+ C(X_2X_4) + C(X_3X_4) + U(X_4)$$

Computational Formula for the Percent of Variance Associated With the Schools Students Attend

The correction for the appropriate degrees of freedom is a modification of the shrinkage formula for a multiple correlation. (See Thorndike, 1949, p. 204). To use this formula each school is regarded as a dummy variable or pseudo variable where a student is assigned a one if he

attends that school and zero otherwise. This results in one dummy variable for each school and the dependent variable is regressed against the dummy variables. The formula used is:

$$\hat{P}^2 = 1 - \frac{(N-1)\ (1-R^2)}{N-p}$$

where $\hat{P}^2$ = the corrected squared multiple correlation

N = the number of students

n = the number of schools

p = n - 1

R^2 = the ratio of the among school variance (S_A^2), to the total variance (S^2T); $S_A^2/S^2T = R^2$